

9.7 Emission factor documentation for AP-42 Section 6.7 (9.7)
Cotton Ginning, Final Report

May 28, 1993

**Emission Factor Documentation for AP-42
Section 6.7**

Cotton Ginning

Final Report

**For U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Inventory Branch
Research Triangle Park, NC 27711**

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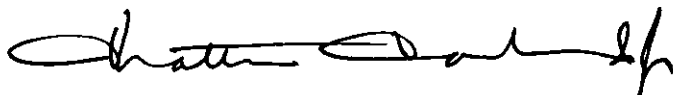
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PREFACE

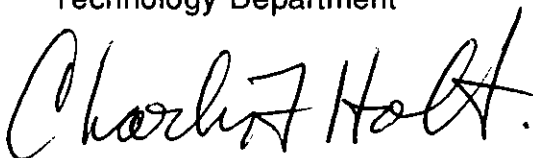
This report was prepared by Midwest Research Institute (MRI) for the Office of Air Quality Planning and Standards (OAQPS), U.S. Environmental Protection Agency (EPA), under Contract No. 68-D2-0159, Assignment No. 005. Mr. Dallas Safriet was the requester of the work. The report was prepared by Mr. David Reisdorph, Mr. John Kinsey, Mr. Lance Henning, and Ms. Jamie Rusconi. Editorial services were provided by Ms. Melisande Skillicorn. The document was processed by Ms. Alice Crews. The MRI Project Leader was Ms. Margaret Thomas.

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SECTION 1

INTRODUCTION

The document *Compilation of Air Pollutant Emissions Factors* (AP-42) has been published by the U.S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been issued to add new emission source categories and to update existing emission factors. The EPA also routinely updates AP-42 in response to the needs of federal, state, and local air pollution control programs and industry.

An emission factor relates the quantity (weight) of pollutants emitted to a unit of source activity. Emission factors reported in AP-42 are used to:

1. Estimate areawide emissions;
2. Estimate emissions for a specific facility; and
3. Evaluate emissions relative to ambient air quality.

This background report supports revisions to AP-42 Section 6.7, Cotton Ginning. Although insufficient data were found to develop new or revised emission factors for cotton ginning, the process description was revised and the Emissions and Controls subsection was changed to reflect the presence of minute amounts of hazardous air pollutants.

This report contains five sections. Following this introduction, Section 2 gives a description of the cotton ginning industry, including a brief characterization of the industry, process operations, air emissions, and emission control technology. Section 3 describes the literature search and criteria used to select and rate emission data and emission factors for use in AP-42 documents. Section 4 details emission factor development for cotton ginning. Section 5 presents the proposed AP-42 Section 6.7, Cotton Ginning.

SECTION 2

INDUSTRY DESCRIPTION

2.1 INDUSTRY CHARACTERIZATION¹⁻⁸

Cotton ginning (SIC 0724) takes place throughout the Sunbelt. The four main production regions can be classified as:

- Southeast—Virginia south to Alabama
- Mid-South—Kentucky and Missouri south to Mississippi and Louisiana
- Southwest—Texas and Oklahoma
- West—New Mexico, Arizona, Nevada, and California

However, the majority of the ginning facilities are located in Arizona, Arkansas, California, Mississippi, and Texas.

The industry has been moving toward fewer gins with higher processing capacity. There were 2,332 active gins in the United States in 1979 that ginned 14,161,000 bales of cotton. The number of cotton gins in the United States had dropped to 1,533 by the 1990/1991 season, but about 15,038,000 bales were still produced. The average volume processed per gin in 1990/1991 was 9,810 bales, compared with 7,096 bales during the 1989/1990 season.

Cotton ginning is seasonal. It begins with the maturing of the cotton crop, which varies with geographical distribution, and ends shortly after the cotton harvest ends. In the United States, the cotton growing seasons are such that each year cotton ginning starts in the Lower Southwest Region in midsummer, continues through the South Central and other geographical regions in late summer and early autumn, and ends on the Upper Southwest Region in late autumn and early winter. The majority of the cotton is ginned between October 1 and December 31. Actually, the bulk of the crop in each geographical region is ginned in 6 to 8 weeks. During the remainder of the year, the gin is idle.

All U.S. cotton in commercial production is now harvested by machines. The methods of harvest which are most prevalent in the American ginning industry are machine picking and machine stripping. Machine-picked cotton accounts normally for 60% to 70% of the total cotton harvested, while machine-stripped cotton normally accounts for 30% to 40% of the total acreage. Machine picking differs from machine

stripping mainly in the method by which the seed cotton is removed from the plant. The spindle picker machine selectively separates the exposed seed cotton from the open capsules while the mechanical stripper removes the entire capsule with seed cotton plus bract, leaf, and stem components in the harvested material.

Strippers collect up to six times more leaves, burs, sticks, and trash than the spindle picker machines, and this higher ratio of trash to seed cotton resulting from machine-stripped operations requires gins to have additional equipment for cleaning and trash extraction. Stripper-type cotton is grown in the more arid areas of Texas, Oklahoma, and eastern New Mexico. Stripper-harvested cotton may produce 1,000 pounds (lb) of trash per 500-lb bale of lint, compared to 150 lb of trash per 500-lb bale from spindle-harvested cotton.

2.2 PROCESS DESCRIPTION

Cotton is a natural fiber crop derived from a herbaceous plant of the *Malvaceae* family. The fibers (lint) are attached to and grow from the surface of the seeds which are located inside the capsule (boll). When mature, the capsules open exposing the fiber and seed. Seed cotton is then harvested by machine from fields which may have been treated by harvest aids such as defoliants and desiccants. The first mechanical process for the seed cotton following harvesting is ginning, the primary aim of which is to separate the fiber from the seed and to bale the lint cotton.

The modern cotton gin is fully automated and can remove 90% to 99% of the trash and seed from the lint. It takes about 1,500 lb of spindle-harvested seed cotton or about 2,400 lb of stripper-harvested seed cotton to produce a 500-lb bale of lint cotton.

The elimination of hand picking has required gins to install additional extracting and cleaning machines in order to maintain quality and grade levels demanded by their mill customers. The modern gin is equipped with many accessories employing several different physical principles that dry the seed cotton; remove green bolls; separate soil, stick, and capsule components (burs) from seed cotton; remove lint from seed; humidify if necessary; remove plant and soil trash from ginned lint; align and smooth the fibers; and package the fiber into a bale for transport and storage.

A typical cotton ginning facility is divided into five processing areas: unloading, drying and cleaning seed cotton, ginning, lint cleaning, and baling. Each stage is shown in Figure 2-1 and is briefly described below.

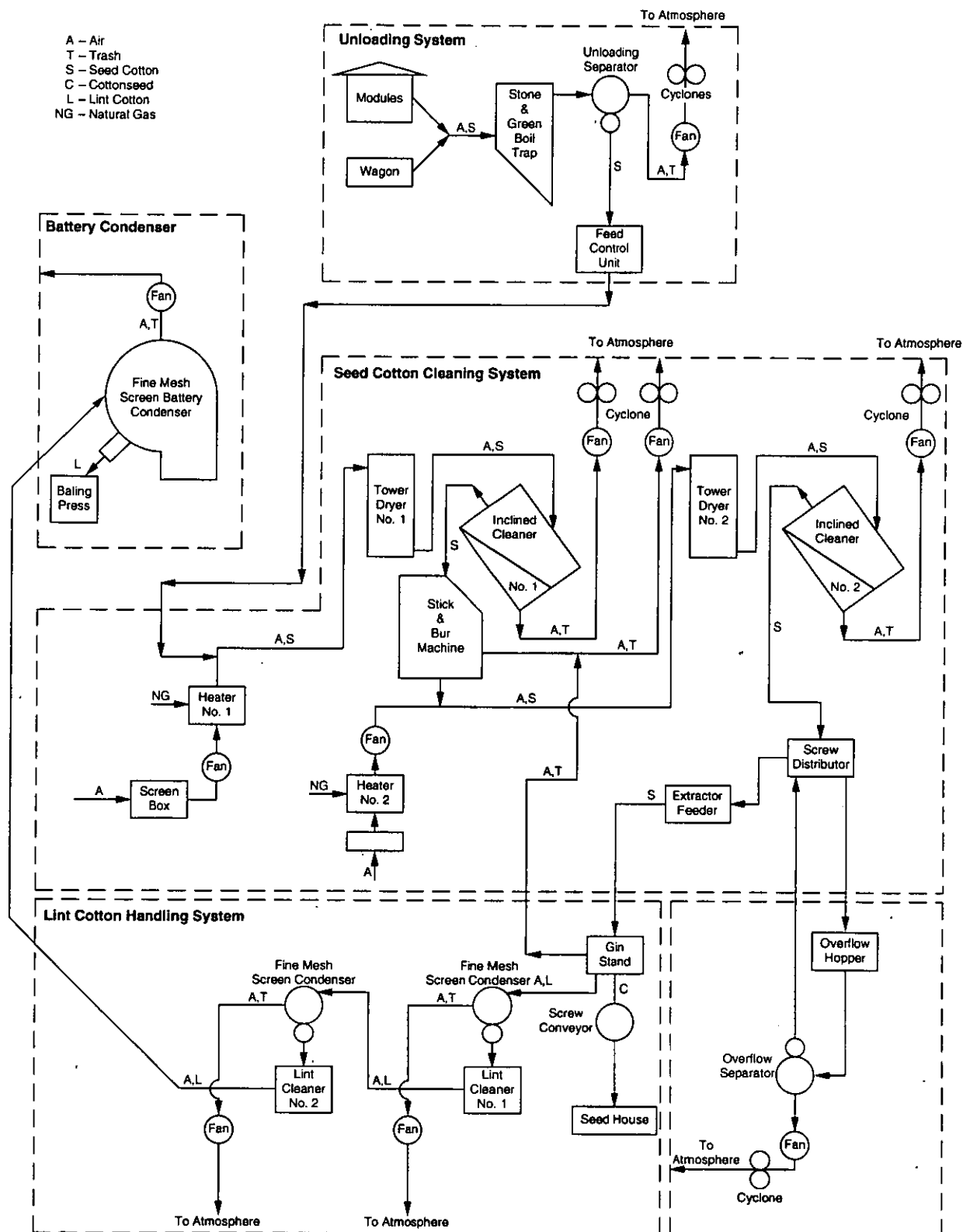


Figure 2-1. Flow diagram of cotton ginning process.

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2.2.1 Unloading System

Seed cotton is normally conveyed from the mechanical harvester to storage trailers or modules. These are delivered to the gin by the producer and the cotton is pneumatically removed and fed into most ginning systems. Some gins, however, are equipped with a modular feeding system that feeds seed cotton by a combination of conveyors and pneumatics into the plant. Once it enters the process flow, the seed cotton is conveyed pneumatically through all subsequent process operations.

Prior to the first separator, some gins utilize a stone and green boll trap for preliminary trash removal. The screen assembly in the separator allows the air to escape but collects the seed cotton and allows it to fall into the feed control unit. The conveying air flows from the separator to a cyclone system where it is cleaned and discharged to the atmosphere.

2.2.2 Seed Cotton Cleaning System

Seed cotton is subjected to three basic conditioning processes—drying, cleaning, and extracting—before it enters the gin stand for lint-seed separation. The type and quantity of equipment used varies according to growing region, types of cotton produced, and operator preference. To ensure adequate conditioning, cotton gins typically use two conditioning systems in series (see Figure 2-1).

Cotton dryers are designed to reduce the moisture content of the seed cotton to 6.5% to 8% to facilitate cleaning and fiber-seed separation. Normally, a high-pressure pneumatic conveyor system brings the raw cotton through tower dryers to the cleaning machines. The dryers serve to bring the cotton to the optimum moisture level of 6.5% to 8.0%. A high moisture content makes the cotton fibers more resistant to breakage, and a low moisture content allows the cotton to be easily cleaned.

The first seed cotton cleaner loosens the cotton and removes fine particles of foreign matter such as leaf trash, sand, and dirt. In the second cleaner large pieces of foreign matter (e.g., sticks, stems, and burs) are removed from the seed cotton by a different process, referred to as "extracting." Several types of extractors are used at cotton gins: bur machines, stick machines, stick and bur machines, stick and green leaf extractors, and extractor-feeders. These types of machines remove burs, sticks, stems, leaves, sand, and dust and pneumatically convey them to the trash storage area. Afterwards, the seed cotton is pneumatically conveyed to the next processing step. All conveying air is cleaned by a cyclone before being released to the atmosphere.

2.2.3 Overflow System

From the final conditioning system, the seed cotton enters a screw conveyor distributor, which apportions the seed cotton to the extractor-feeders in a controlled

rate. The extractor-feeders drop the seed cotton into the gin stands at a rate consistent with the recommended processing rates. When the flow of seed cotton exceeds the limit of the extractor-feeder-gin stand systems, the excess seed cotton flows into the overflow hopper. A pneumatic system transfers this seed cotton from the overflow hopper back to the screw conveyor distributor as required. The air from this system is routed through a cyclone where it is cleaned before being exhausted to the atmosphere.

2.2.4 Lint Cotton Handling System

Seed cotton enters the gin stand through a "huller front" which performs some cleaning. Saws grasp the locks of cotton and draw them through a widely spaced set of "huller ribs" (some gin stands do not have huller ribs) which strip off hulls and sticks. The cotton locks are then drawn into the roll box, where fibers are separated from the seeds. After all the fibers are removed, the seeds slide down the face of the ginning ribs and fall to the bottom of the gin stand for subsequent removal to storage. The size and capacity of the gin plant are determined by the number of gin stands it houses. Ginning facilities usually contain from one to five stands, with three or four being most common.

Cotton lint is removed from the saws of the gin stand by a rotating brush or a blast of air and conveyed pneumatically to the lint cleaning system for final cleaning and combing. The lint cotton is separated from the conveying airstream by a condenser that forms the lint into a batt. The lint batt is fed into the first lint cleaner, where saws comb the lint cotton and further remove leaf particles, grass, and motes. Some condensers are covered with fine mesh wire or fine perforated metal which acts as a filter to remove short lint fibers and some dust from the conveying air.

2.2.5 Battery Condenser and Baling System

Lint cotton is pneumatically transported from the lint cleaning system to a battery condenser/separator, which consists of a drum covered with fine mesh screen or fine perforated metal that separates the lint cotton from the conveying air.

Most gins use a double-press box for packaging the cotton into bales. The lint drops into one press box and fills it while a bale is being pressed and strapped in the other box. Approximately 480 lb (217 kilograms [kg]) of cotton is pressed into a bale before it is wrapped with a cover, and strapped. One-half of all the U.S. gins operate at a rate of 8 bales per hour or less, and only about 8% are rated at 19 bales per hour or more. Cotton bales produced in most gins are not compact enough to meet shipping requirements; thus, they must be sent to a compress-warehouse for further compressing. Modern gins are presently equipped with higher-tonnage bale presses that produce the more compact "universal sized" cotton bales and are also equipped with cotton sampling instruments, therefore bypassing the compress-warehouse route. The finished cotton bale is transported to the textile mill for processing into yarn.

2.3 EMISSIONS

Particulate matter is a primary air pollutant emitted from the cotton ginning process. All processes in a gin involve dust generation from the trash, seeds, and lint cotton. The amount of particulate emissions varies depending on the type of gin, geographic region, type of cotton, harvest method, trash content, climate, production rate, and type and number of controls used by the facility. The air from each step in the process goes through a control device before being vented to the atmosphere.

2.4 EMISSION CONTROL TECHNOLOGY⁷⁻¹⁴

Cyclones are the principal control for particulate emissions on high-pressure airstreams in cotton gins. Properly designed and operated 2D2D or 1D3D cyclones remove over 99% of particulate by weight, and nearly 100% of particulate greater than 25 microns (μm). Cyclones operated in series have also proven successful. Testing showed combined collection of particulate for two 2D2D cyclones in series to be 99.82%. For a 2D2D cyclone followed by a 1D3D cyclone, the removal of particulate averaged 99.86%.

Skimmers are used as primary control devices with a secondary control device following the skimmer. They may be used on high-pressure systems in place of cyclones or on low-pressure systems. The collection efficiency has been reported at 50% removal of particulate by weight.

Unifilters handle exhaust from low- and high-pressure systems. Laboratory testing found an average of 99% removal of particulate by weight. In operation, the unifilters have had performance problems such as clogging and rapid degradation of the filter media.

In-line air filters have been used on low-pressure systems, but are rarely used in today's cotton gins. Past testing indicated the in-line filters had a 75% particulate removal efficiency.

A condenser drum covering reduces particulate by 50% in a low-pressure system. By covering the condenser drum with fine metal screen or with perforated metal, large particulate can be effectively eliminated from emissions.

Wet scrubbers have been used with little success as primary control. The efficiency of particulate removal is lower than cyclones and the scrubber creates a water and sludge disposal problem. However, wet scrubbers have been proven successful as a secondary control device with cyclones. Testing indicated a wet scrubber can remove 73.5% of the particulate exhausted by a cyclone, which captured an average of 90.8% of gin emissions. Particulate removal for the combined system averaged 97.6%.

REFERENCES FOR SECTION 2

1. *Source Assessment: Cotton Gins*, EPA Contract No. 68-02-1874, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1978.
2. *Control Technology Assessment of Raw Cotton Processing Operations*, Enviro Control Inc. Prepared for the National Institute for Occupational Safety and Health, Cincinnati, OH, June 15, 1980.
3. Edward H. Glade, Jr., et al., *Cotton Ginning Charges: Harvesting Practices & Selected Marketing Costs 1990/91*, USDA Economic Research Service, ERS Staff Report, AGS-9157, November 1991.
4. A. C. Griffin and E. P. Columbus, *Dust in Cotton Gins: An Overview*. Prepared for the U.S. Cotton Ginning Laboratory, Stoneville, MS, 1982.
5. *Cotton Ginners Handbook*, Agricultural Handbook No. 503, Agricultural Research Service, U.S. Department of Agriculture, 1977, U.S. Government Printing Office, Stock No. 001-000-03678-5.
6. Written communication from Phillip J. Wakelyn and Fred Johnson, National Cotton Council of America, Washington, D.C., to David Reisdorph, Midwest Research Institute, Kansas City, MO, December 30, 1992.
7. *Respiratory Disorders and Dust Exposure in Sectors of the Cotton Industry of the United States. Part 1. Cotton Gins*, National Institute for Occupational Safety and Health, Morgantown, WV, November 1981.
8. M. N. Gillum et al., *Primary and Secondary Cleaning of Lint Cleaner Exhaust Air: A Progress Report*, Transactions of the American Society of Agricultural Engineers, 1981, pp. 1605-1612.
9. S. E. Hughs et al., *Collecting Particles from Gin Lint Cleaner Air Exhausts*, Transactions of the American Society of Agricultural Engineers, 1982, pp. 1435-1438.
10. M. N. Gillum and S. E. Hughs, *Velocity Effects on Operating Parameters of Series Cyclones*, Transaction of the American Society of Agricultural Engineers, 1983, 26(2):606-609.
11. E. P. Columbus and W. S. Anthony, *Condenser Coverings to Reduce Gin Emissions*, In: Proceedings Beltwide Cotton Production Research Conferences, Nashville, TN, pp. 973-975, National Cotton Council, Memphis, TN.

12. E. P. Columbus, *Series Cyclone Arrangements to Reduce Gin Emissions*, Transactions of the American Society of Agricultural Engineers, 1993, 36(2):pages unknown.
13. Oliver L. McCaskill and Richard A. Wesley, *Tests Conducted on Exhausts of Gins Handling Machine Picked Cotton*, The Cotton Gin and Oil Mill Press, September 5, 1970, pp. 7-9.
14. M. N. Gillum et al., *Use of Secondary Cyclones for Reducing Gin Emissions*, Transactions of the American Society of Agricultural Engineers, 1982, 25(1):210-213.

SECTION 3

GENERAL DATA REVIEW AND ANALYSIS PROCEDURES

This section describes the literature search to collect emissions data and the EPA quality rating systems applied to data and to any emissions factors developed from those data.

3.1 LITERATURE SEARCH AND SCREENING

A literature search was performed to collect pertinent emissions data for operations associated with cotton ginning. This search included documents obtained from EPA's Office of Air Quality Planning and Standards (OAQPS), reports from the U.S. Department of Agriculture Library, documents listed in *Dialog Information Services*, source tests on record with the Fresno County Air Pollution Control District, and data base searches on the Crosswalk/Air Toxic Emission Factors Data Base Management System (XATEF), the VOC/PM Speciation Data Base Management System (SPECIATE), and the Air Chief CD-ROM.

During the review of each document, the following criteria were used to determine the acceptability of reference documents for emission factor development:

1. The report must be a primary reference:
 - a. Source testing must be from a referenced study that does not reiterate information from previous studies.
 - b. The document must constitute the original source of test data.
2. The referenced study must contain test results based on more than one test run.
3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions.

3.2 DATA QUALITY RATING SYSTEM¹

Based on OAQPS guidelines, the following data are always excluded from consideration in developing AP-42 emission factors:

1. Test series averages reported in units that cannot be converted to the selected reporting units;
2. Test series representing incompatible test methods; and
3. Test series in which the production and control processes are not clearly identified and described.

If there is no reason to exclude a particular data set, data are assigned a quality rating based on an A to D scale specified by OAQPS as follows:

A—This rating requires that multiple tests be performed on the same source using sound methodology and reported in enough detail for adequate validation. Tests do not necessarily have to conform to the methodology specified by EPA reference test methods, although such methods are used as guides.

B—This rating is given to tests performed by a generally sound methodology but lacking enough detail for adequate validation.

C—This rating is given to tests that are based on an untested or new methodology or that lack a significant amount of background data.

D—This rating is given to tests that are based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following are the OAQPS criteria used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated should be well documented in the report, and the source should be operating within typical parameters during the test.
2. Sampling procedures. The sampling procedures should conform to a generally accepted methodology. If actual procedures deviate from accepted methods, the deviations must be well documented. When this occurs, an evaluation should be made of how such alternative procedures could influence the test results.
3. Sampling and process data. Adequate sampling and process data should be documented in the report. Many variations can occur without warning

during testing and sometimes without being noticed. Such variations can induce wide deviations in sampling results. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.

- 4.. Analysis and calculations. The test reports should contain original raw data sheets. The nomenclature and equations used are compared to those specified by EPA (if any) to establish equivalency. The depth of review of the calculations is dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn is based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM¹

EPA guidelines specify that the quality of the emission factors developed from analysis of the test data be rated utilizing the following general criteria:

A—Excellent: The emission factor was developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category* was specific enough to minimize variability within the source category population.

B—Above average: The emission factor was developed only from A-rated test data from a reasonable number of facilities. Although no specific bias was evident, it was not clear if the facilities tested represented a random sample of the industries. As in the A-rating, the source category was specific enough to minimize variability within the source category population.

C—Average: The emission factor was developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias was evident, it was not clear if the facilities tested represented a random sample of the industry. As in the A-rating, the source category was specific enough to minimize variability within the source category population.

D—Below average: The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there was reason to suspect that these facilities did not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are footnoted in the emission factor table.

E—Poor: The emission factor was developed from C- and D-rated test data, and there was reason to suspect that the facilities tested did not represent a random

* Source category: A category in the emission factor table for which an emission factor has been calculated.

sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are footnoted.

The use of the above criteria is somewhat subjective depending to a large extent on the individual reviewer. Details of how each candidate emission factor was rated are provided in Section 4.

REFERENCE FOR SECTION 3

1. *Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections*, Draft, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 1992.

SECTION 4

AP-42 SECTION DEVELOPMENT

This section describes the references and test data that were evaluated to determine whether revisions or additions were appropriate to AP-42 Section 6.7, Cotton Ginning.

4.1 REVIEW OF SPECIFIC DATA SETS

A brief summary of the documents selected for review from the literature search is given below. Full citations are given at the end of this section.

Reference 1

This reference contains an Emissions Inventory Plan for compliance with California's AB 2588 for a ginning facility in Fresno County, California. The plan contains production records, site plan, flow diagram, description of the process, and data from the California Cotton Ginners Association. Substances and quantities of emissions are reported; however, these figures come from a source test at another facility. The emission factor for particulate per bale has no data or description to explain its origin. Since the data are all secondhand, these data were unusable.

Reference 2

This report summarizes the results of studies and surveys of airborne dust conducted within cotton gins in the United States. Some valuable information is included, such as the fact that stripper cotton processing has higher dust levels than spindle picked cotton, and roller gins are dustier than saw gins. Several tables give dust concentrations in various gins across the country, and there is a discussion of gin dust composition. No emission tests are included in the report, and it deals only with dust levels in the gins.

Reference 3

This reference is a source test for particulate emissions using EPA Method 5. A process flow diagram, process description, and analytical procedures description are included. Fifteen points were sampled. Nine were atmospheric emission points, and three were inlet points to measure the efficiency of the control devices. The summary

of emissions includes calculated emission factors. The test data were given an A rating, but this report is not a new data source. It was used as part of the *Source Assessment Document No. 27, Cotton Gins*, by Monsanto Research Corporation, which was used as reference 2 for documenting the 1977 AP-42 emission factors.

Reference 4

This document is an excellent source test for particulate emissions. Fourteen emission points controlled by 26 cyclones and 4 filters were sampled using EPA Method 5. From the data summary, an emission factor for each point was calculated. A process description and plant flow diagram are also included. This is an A-rated source test. However, this report also is not a new data source. It was used as part of the *Source Assessment Document No. 27, Cotton Gins*, by Monsanto Research Corporation, which was used as reference 2 for documenting the 1977 AP-42 emission factors.

Reference 5

This is the report of a source emission test at the Valley Gin Company, Peoria, Arizona. Test points included the master trash fan and the in-line filter following the first stage Linter Cleaner Condenser. The document contains a good process description with flow diagram and a good data summary of all test results. It is an A-rated source test. Again, this report is not a new information source. It was referenced as part of the I. W. Kirk document used as reference 7 for developing the 1977 AP-42 emission factors.

Reference 6

Saw and roller gins were studied to determine the nature and magnitude of the dust problems in gins. Four gins in Mesilla Valley, New Mexico, were sampled using five different methods. The samples were taken in the gin stand and bale press areas. The summary of results includes concentration levels and the analysis of the dust makeup. However, this report is not an emission source test, and it deals only with dust levels within the gins.

Reference 7

A power plant, a steel plant, and a cotton gin were sampled with an in-stack cascade impactor for total particulate matter and elemental metal content. Controls were sampled by measuring the inlet and outlets of the control device at each site. The sample was taken from a wet scrubber receiving effluent from a battery condenser. The test was given a C rating.

This report had some process information, but little description of the cotton gin plant and its location. There is some question as to whether or not a wet scrubber is

a representative control device, since many cotton gins use cyclones. Most important, this report was not an emission source test. After passing through the wet scrubber, the air went back into the plant area.

Reference 8

This document describes a source test for a large gin in Fresno using two rotating filters as a control device. The test used a modified EPA Method 5, a type of control not necessarily representative of the industry. The gin emissions were found to be about one-half the emissions from a facility using a cyclone system. The report has no original data, only second-hand information. The facility descriptions, process information, and test results are only briefly summarized.

Reference 9

This article describes a new ginning machine developed at the Ginning Research Laboratory. The machine puts in seed cotton and outputs clean cotton for baling. This method eliminates the need for three separate machines in the ginning process. The article contains no source emission information.

Reference 10

This report discusses dust levels determined in three work areas of five high-capacity, saw-type cotton gins processing spindle-picked cotton. Analyses of the dust concentration showed it was variable in the different work areas and the different gins. The report contains no source emission tests. All tests were of dust concentrations within the working areas.

Reference 11

This article describes a method for composting gin trash with chicken manure. No emissions data are provided.

Reference 12

This report presents the method, operational experiences, and results of tests obtained using a high-volume stack sampler. The Tennessee Division of Air Pollution Control evaluated the performance of the high-volume sampler because it could be an alternative to the high cost of EPA Method 5. The sampler, procedure, and analysis are well described. Emissions from six gins in Tennessee were tested. The report includes a summary table of the emissions. However, no description of the gins and their processes or raw data are included.

Reference 13

This report contains tests from two gins of stripper-harvested cotton in Texas and three gins of spindle-harvested cotton in the mid-South. The samples were taken within the gins. Summary results of the dust concentration and dust levels are reported. There are no source test emissions to the atmosphere, however.

Reference 14

Silica was determined in total dust samples from within cotton gins, compresses, waste utilization plants, and oil mills. Fine dust in electrostatically precipitated samples from a model cardroom was also analyzed. The report discusses the results from the samples and the histamine release activity. All samples were taken within the cotton gins, and there were no sources to the atmosphere.

Reference 15

Air samples were taken downwind of two gins processing stripper cotton in Texas. Samples were taken using high-volume samplers (to measure total suspended particulate matter) and four types of PM-10 size selective inlets. Data were analyzed using analyses of variance, analyses of covariance, and Duncan's multiple range test. PM-10 concentration levels measured by size selective inlets were compared to corresponding "actual" PM-10 concentration levels. The test was given a D rating.

The tests used are not generally accepted for testing cotton gins. In addition, there was no information on the cotton gins and their processes.

Reference 16

This report is a control technology assessment utilizing data from preliminary and detailed surveys in cotton ginning, cottonseed processing, yarn manufacturing, knitting, weaving, and waste processing operations that utilize raw cotton. The controls selected were local and general exhaust ventilation, air filtration equipment, work practices, process enclosure and isolation, personnel protective equipment, and liquid oversprays. All information pertained to the work area within the gin, and no atmospheric emission tests are included.

Reference 17

Five hundred fifty-one cotton gin workers and 1,218 workers in nondusty comparison plants were studied in a cross-sectional industrial hygiene and respiratory disease prevalence survey of 37 gins throughout the Cotton Belt in the United States. The industrial hygiene study consisted of the determination of ambient respirable cotton dust levels with vertical elutriators and the characterization of particle size

distribution. All information pertains to the work area within the gin. The report has no atmospheric emission tests.

Reference 18

Electrostatically precipitated respirable dusts from six major U.S. cotton crop varieties and growing areas were analyzed. The tests were taken from five of the U.S. production areas in the air exhaust dust of the cardroom. The makeup of the dust was analyzed and discussed with its relation to byssinosis. The report could not be utilized, since it looks at dust concentrations only within the cotton gin.

Reference 19

A dynamic programming model of a cotton ginning system was developed in response to the need to optimize energy usage in cotton gins and to maximize returns to farmers. Performance tables indicating the influence of each stage of the ginning process on moisture content, composite grade, and lint turnout were developed for a small-scale ginning system and used as a transfer function in the model. If the model were used in a specific ginning system, the performance tables in the model could be used, or the existing tables could be adjusted to more correctly reflect the performance characteristics in the specific ginning system. However, no source tests for emissions are included in this document.

Reference 20

Raw cotton from four machine-picked varieties and two machine-stripped varieties is examined by stereomicroscope and bright-field microscope for the presence of plant trash, which creates cotton dust during yarn manufacturing operations. Bract was found to be the major trash component in all raw cottons examined. Cotton leaf and noncotton weed materials were also major trash components in most raw cottons. However, the document does not contain any source emission tests.

Summary

Table 4-1 summarizes the review of 21 references for purposes of developing new or revised emission factors for AP-42 Section 6.7, Cotton Ginning. While new emission factors could not be developed based on these references, parts of the AP-42 narrative were updated.

TABLE 4-1. DOCUMENTS REVIEWED FOR EMISSION FACTOR DEVELOPMENT

Reference No.	Comments
1	Rejected—Second-hand data and process description lacking
2	Rejected—No source emission tests
3	Used in current AP-42 emission factor
4	Used in current AP-42 emission factor
5	Used in current AP-42 emission factor
6	Rejected—No source emission tests
7	Rejected—Insufficient process description and not an emission source
8	Rejected—Second-hand data
9	Rejected—No source emission test
10	Rejected—No source emission test
11	Rejected—No source emission test
12	Rejected—No process description or raw data
13	Rejected—No source emission test
14	Rejected—No source emission test
15	Rejected—No process information and an unaccepted method of testing
16	Rejected—No source emission test
17	Rejected—No source emission test
18	Rejected—No source emission test
19	Rejected—No source emission test
20	Rejected—No source emission test

4.2 DEVELOPMENT OF CANDIDATE EMISSION FACTORS

As stated above, none of the references found in the literature search could be used to develop or revise the emission factors for the AP-42. The discussion which follows notes new information on metal emissions, but this information could not be used for emission factor development.

Metal Emissions²¹

Gin external emissions, because they contain soil, almost certainly contain trace amounts of metals that are listed among the 189 air toxic chemicals in the Clean Air Act of 1990. However, the final list of categories of major and area sources of the 189 air toxics (57 FR 31576; July 16, 1992) does not present cotton gins as a major or area source of any of these toxics. Direct data on the amounts of soil contamination and the chemical makeup of gin emissions is expected to be available in the fall of 1993 from the USDA, Agricultural Research Service, Southwestern Cotton Ginning Research Laboratory, Mesilla Park, New Mexico.

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21. Personal correspondences to Mr. Dallas Safriet, U.S. EPA, from Dr. Phillip Wakelyn, National Cotton Council of America, 1521 New Hampshire Avenue, NW, Washington, DC 20036, dated April 16, 1993; and Mr. S. E. Hughs, USDA, Agricultural Research Service, Southwestern Cotton Ginning Research Laboratory, P.O. Box 578, Mesilla Park, NM 88047, dated April 9, 1993.

SECTION 5

PROPOSED AP-42 SECTION 6.7

The proposed AP-42 Section 6.7, Cotton Ginning, is presented on the following pages as it would appear in the document.

6.7 COTTON GINNING

6.7.1 General^{1,10-14}

Cotton ginning (SIC 0724) takes place throughout the Sunbelt. The four main production regions can be classified as:

- Southeast—Virginia south to Alabama
- Mid-South—Kentucky and Missouri south to Mississippi and Louisiana
- Southwest—Texas and Oklahoma
- West—New Mexico, Arizona, Nevada, and California

However, the majority of the ginning facilities are located in Arizona, Arkansas, California, Mississippi, and Texas.

The industry has been moving toward fewer gins with higher processing capacity. There were 2,332 active gins in the United States in 1979 that ginned 14,161,000 bales of cotton. The number of cotton gins in the United States had dropped to 1,533 by the 1990/1991 season, but about 15,038,000 bales were still produced. The average volume processed per gin in 1990/1991 was 9,810 bales, compared with 7,096 bales during the 1989/1990 season.

Cotton ginning is seasonal. It begins with the maturing of the cotton crop, which varies with geographical distribution, and ends shortly after the cotton harvest ends. In the United States, the cotton growing seasons are such that each year cotton ginning starts in the Lower Southwest Region in midsummer, continues through the South Central and other geographical regions in late summer and early autumn, and ends on the Upper Southwest Region in late autumn and early winter. The majority of the cotton is ginned between October 1 and December 31. Actually, the bulk of the crop in each geographical region is ginned in 6 to 8 weeks. During the remainder of the year, the gin is idle.

All U.S. cotton in commercial production is now harvested by machines. The methods of harvest that are most prevalent in the American ginning industry are machine picking and machine stripping. Machine-picked cotton accounts normally for 60 to 70 percent of the total cotton harvested, while machine-stripped cotton normally accounts for 30 to 40 percent of the total acreage. Machine picking differs from machine stripping mainly in the method by which the seed cotton is removed from the plant. Machine picking is done by a spindle picker machine that selectively separates the exposed seed cotton from the open capsules. In contrast, the mechanical stripper incorporates the entire capsule with lint plus bract, leaf, and stem components in the harvested material.

Strippers collect up to six times more leaves, burs, sticks, and trash than the spindle picker machines, and this higher ratio of trash to lint resulting from machine-stripped operations requires gins to have additional equipment for cleaning and trash extraction. Stripper-type cotton is grown in the more arid areas of Texas, Oklahoma, and eastern New Mexico. Stripper-harvested cotton may produce 1,000 pounds of trash per 500-pound bale of lint, compared to 150 pounds of trash per 500-pound bale from spindle-harvested cotton.

6.7.2 Process Description²

Figure 6.7-1 is a flow diagram of the typical cotton-ginning process. Each of the five ginning steps and associated equipment is described below.

Unloading System — Trucks and trailers transport cotton from the field to the gin. A pneumatic system removes the cotton from the trailers, and a combination conveyer and pneumatic system conveys the cotton to a separator and feed control unit. Prior to this first separator point, some gins use a stone and green boll trap for preliminary trash removal. The screen assembly in the separator allows air to escape but collects the cotton and allows it to fall into the feed control unit. The conveying air flows from the separator to a cyclone system, where it is cleaned and discharged to the atmosphere.

Cotton Cleaning System — Cotton is subjected to three basic conditioning processes — drying, cleaning, and extracting — before it is processed for separation of lint and seed. To ensure adequate conditioning, cotton gins typically use two conditioning systems in series (see Figure 6.7-1).

Cotton dryers are designed to reduce cotton moisture content to 6.5 to 8 percent to facilitate cleaning and fiber/seed separation. A push-pull, high-pressure fan system conveys seed cotton through the tower dryer to the first seed cotton cleaner, which loosens the cotton and removes fine particles of foreign matter (e.g., leaf trash, sand, and dirt). In the second cleaner, large pieces (e.g., sticks, stems, and burs) are removed from the cotton by a different process, referred to as "extracting." Different types of extractors may be used at gins, including bur machines, stick machines, stick and bur machines, stick and green leaf extractors, and extractor/feeders. These machines remove burs, sticks, stems, and large leaves, pneumatically conveying them to the trash storage area. The cotton is pneumatically conveyed to the next processing step. All conveying air is cleaned by a cyclone before being released to the atmosphere.

Overflow System — After cleaning, the cotton enters a screw conveyor distributor, which apportions the cotton to the extractor/feeders at a controlled rate. The extractor/feeders drop the cotton into the gin stands at the recommended processing rates. If the flow of cotton exceeds the limit of the extractor/feeder systems, the excess cotton flows into the overflow hopper. A pneumatic system then returns this cotton back to the screw conveyor distributor, as required. The air from this system is routed through a cyclone and cleaned before being exhausted to the atmosphere.

Lint Cotton Handling System — Cotton enters the gin stand through a "huller front" which performs some cleaning. Saws grasp the locks of cotton and draw them through a widely spaced set of "huller ribs" that strip off hulls and sticks. (Some gin stands do not have huller ribs.) The cotton locks are then drawn into the roll box, where fibers are separated from the seeds. After all the fibers are removed, the seeds slide down the face of the ginning ribs and fall to the bottom of the gin stand for subsequent removal to storage. Cotton lint is removed from the saws by a rotating brush, or a blast of air, and is conveyed pneumatically to the lint cleaning system for final cleaning and combing. The lint cotton is removed from the conveying airstream by a condenser that forms the lint into a batt. The lint batt is fed into the first lint cleaner, where saws comb the lint cotton again and remove any remaining leaf particles, grass, and motes. Most condensers are covered with fine mesh wire or fine perforated metal, which acts to filter short lint fibers and some dust from the conveying air.

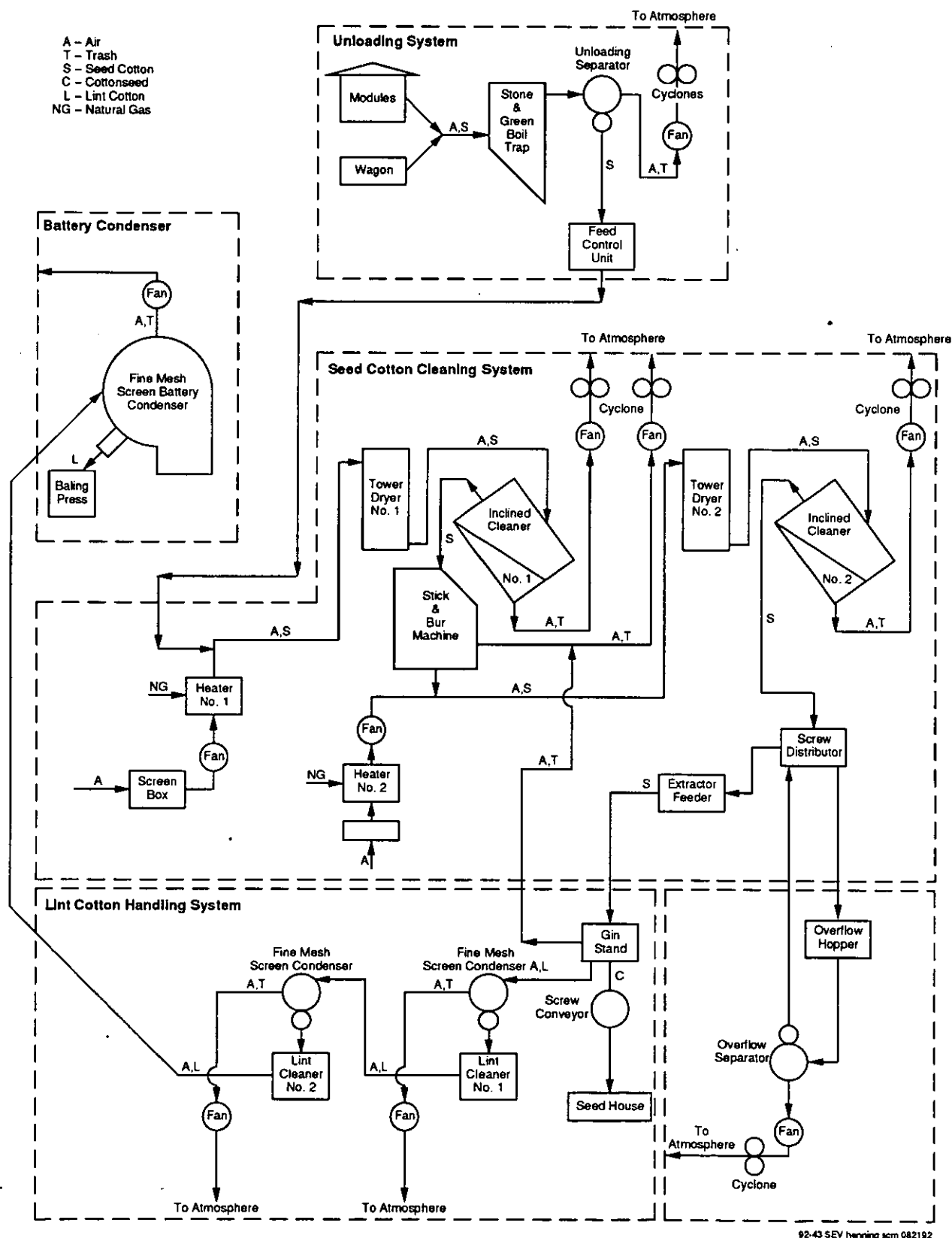


Figure 6.7-1. Flow diagram of cotton-ginning process.

Battery Condenser And Baling System — Lint cotton is pneumatically transported from the lint cleaning system to a battery condenser, which is a drum covered with fine mesh screen or fine perforated metal that separates the lint cotton from the conveying air. The lint cotton is formed into batts and fed into a baling press, which compresses it into uniform bales of cotton.

6.7.3 Emissions And Controls¹⁻⁹

Emissions — Particulate matter is the major air pollutant emitted from the cotton- ginning process. Lint fly, dust, fine leaves, and other trash compose the particulate matter. Figure 6.7-2 shows 10 points in the ginning process where particulate emissions would typically occur.

Tables 6.7-1 and 6.7-2 present emission factors from uncontrolled cotton ginning operations. Tables 6.7-3 and 6.7-4 present emission factors for a typical cotton gin equipped with available control devices. The emissions data base reflects cotton gins with cyclones and screen coverings on condensers. The total emission factor can be expected to vary by roughly a factor of 2, depending on the type of cotton, trash content of the cotton, maintenance of control devices, and plant operation procedures.

Insufficient data are available for determining emission factors for metals.

Controls — Two primary methods of particulate control are in use: (1) high-efficiency cyclones on the high-pressure fan discharges with collection efficiencies that can exceed 99 percent and (2) fine screen coverings on condenser drums in the low-pressure systems with efficiencies of approximately 50 percent.

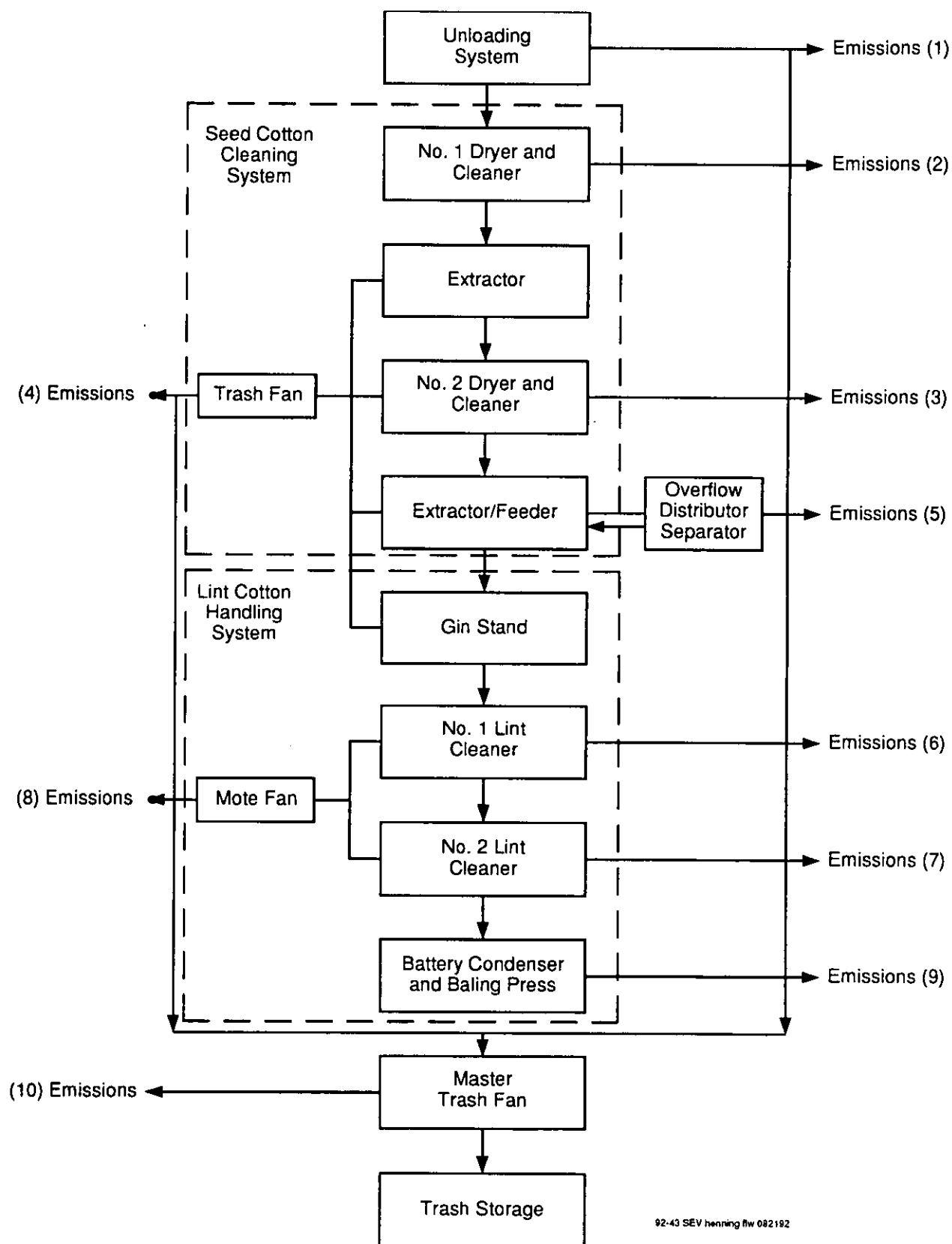


Figure 6.7-2. Emissions from a typical ginning operation.

Table 6.7-1 (Metric Units).
UNCONTROLLED EMISSION FACTORS FOR COTTON-GINNING OPERATIONS^a

EMISSION FACTOR RATING: C

Process (SCC)	Estimated total particulate kg/bale	Percentage of particles > 100 μ m settled out ^b	Estimated emission factor (released to atmosphere) kg/bale
Unloading fan ^c (30200401)	2.27	0	2.27
Seed cotton cleaning system Cleaners and dryers ^d (30200402)	0.45	70	0.14
Stick and bur machine (30200403)	1.36	95	0.09
Miscellaneous ^e (30200404)	1.36	50	0.68
Total (30200410)	5.44	—	3.2

^aReference 1. SCC = Source Classification Code.

^bPercentage of the particles that settle out in the plant.

^cCorresponds to item 1 in Table 6.7-3.

^dCorresponds to items 2 and 3 in Table 6.7-3.

^eCorresponds to items 4 through 9 in Table 6.7-3.

Table 6.7-2 (English Units).
UNCONTROLLED EMISSION FACTORS FOR COTTON-GINNING OPERATIONS^a

EMISSION FACTOR RATING: C

Process (SCC)	Estimated total particulate lb/bale	Percentage of particles > 100 μ m settled out ^b	Estimated emission factor (released to atmosphere) lb/bale
Unloading fan ^c (30200401)	5	0	5.0
Seed cotton cleaning system Cleaners and dryers ^d (30200402)	1	70	0.3
Stick and bur machine (30200403)	3	95	0.2
Miscellaneous ^e (30200404)	3	50	1.5
Total (30200410)	12	—	7.0

^aReference 1. SCC = Source Classification Code.

^bPercentage of the particles that settle out in the plant.

^cCorresponds to item 1 in Table 6.7-4.

^dCorresponds to items 2 and 3 in Table 6.7-4.

^eCorresponds to items 4 through 9 in Table 6.7-4.

Table 6.7-3 (Metric Units).
CONTROLLED PARTICULATE EMISSION FACTORS FOR COTTON GINS^a

EMISSION FACTOR RATING: C

Emission point ^b (SCC)	Emission factor g/kg
1. Unloading fan (30200401)	0.64
2. No. 1 dryer and cleaner (30200402)	0.36
3. No. 2 dryer and cleaner (30200402)	0.20
4. Trash fan (30200404)	0.08
5. Overflow fan (30200404)	0.16
6. No. 1 lint cleaner condenser (30200402)	1.62
7. No. 2 lint cleaner condenser (30200402)	0.30
8. Mote fan (30200404)	0.40
9. Battery condenser (30200404)	0.38
10. Master trash fan (30200404)	0.34
Total (30200410)	4.48

^aReferences 2, 6-9. SCC = Source Classification Code.

^bNumbers correspond to those in Figure 6.7-2.

Table 6.7-4 (English Units).
CONTROLLED PARTICULATE EMISSION FACTORS FOR COTTON GINS^a

EMISSION FACTOR RATING: C

Emission point ^b (SCC)	Emission factor lb/bale
1. Unloading fan (30200401)	0.32
2. No. 1 dryer and cleaner (30200402)	0.18
3. No. 2 dryer and cleaner (30200402)	0.10
4. Trash fan (30200404)	0.04
5. Overflow fan (30200404)	0.08
6. No. 1 lint cleaner condenser (30200402)	0.81
7. No. 2 lint cleaner condenser (30200402)	0.15
8. Mote fan (30200404)	0.20
9. Battery condenser (30200404)	0.19
10. Master trash fan (30200404)	0.17
Total (30200410)	2.24

^aReferences 2, 6-9. SCC = Source Classification Code.

^bNumbers correspond to those in Figure 6.7-2.

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